

## PCT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
 US Department of Commerce  
 United States Patent and Trademark  
 Office, PCT  
 2011 South Clark Place Room  
 CP2/5C24  
 Arlington, VA 22202  
 ETATS-UNIS D'AMERIQUE  
 in its capacity as elected Office

Date of mailing (day/month/year) 31 May 2001 (31.05.01)	
International application No. PCT/GB00/03483	Applicant's or agent's file reference HL76966/001
International filing date (day/month/year) 08 September 2000 (08.09.00)	Priority date (day/month/year) 08 September 1999 (08.09.99)
Applicant MASSARA, Aeneas, Benedict et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

28 March 2001 (28.03.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Olivia TEFY Telephone No.: (41-22) 338.83.38
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## PCT INTERNATIONAL COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

O'CONNELL, David, Christopher  
Haseltine Lake & Co.  
Imperial House  
15-19 Kingsway  
London WC2B 6UD  
ROYAUME-UNI

Date of mailing (day/month/year) 16 February 2001 (16.02.01)	<b>IMPORTANT NOTIFICATION</b>
Applicant's or agent's file reference HL76966/001	
International application No. PCT/GB00/03483	International filing date (day/month/year) 08 September 2000 (08.09.00)

1. The following indications appeared on record concerning:		
<input checked="" type="checkbox"/> the applicant	<input checked="" type="checkbox"/> the inventor	<input type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address SARJENT, Laurence, John Top Floor Flat 11 Bellevue Clifton Bristol BS8 1DB United Kingdom	State of Nationality GB	State of Residence GB
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input type="checkbox"/> the person	<input checked="" type="checkbox"/> the name	<input type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address SARGENT, Laurence, John Top Floor Flat 11 Bellevue Clifton Bristol BS8 1DB United Kingdom	State of Nationality GB	State of Residence GB
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary:		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input checked="" type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input type="checkbox"/> the elected Offices concerned	
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer I. Britel Telephone No.: (41-22) 338.83.38
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# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>HL76966/001</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/GB 00/ 03483</b>	International filing date (day/month/year) <b>08/09/2000</b>	(Earliest) Priority Date (day/month/year) <b>08/09/1999</b>
Applicant <b>UNIVERSITY OF BRISTOL</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

### 1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established by this Authority to read as follows:

**SEMICONDUCTOR LASER DIODE WITH A DISTRIBUTED REFLECTOR**

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1  
☐ None of the figures.

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03483

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 H01S5/22 H01S5/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	MASSARA A B ET AL: "Mode-hop-free, singlemode operation of 2D lattice distributed reflector laser under 2.5 Gbit/s modulation" ELECTRONICS LETTERS, 20 JAN. 2000, IEE, UK, vol. 36, no. 2, pages 141-142, XP002154423 ISSN: 0013-5194 the whole document --- -/--	1-35



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

## ° Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \* & \* document member of the same patent family

Date of the actual completion of the international search

1 December 2000

Date of mailing of the international search report

13/12/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
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Authorized officer

Hervé, D

## INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 00/03483

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HAN H ET AL: "TWO-DIMENSIONAL RECTANGULAR LATTICE DISTRIBUTED FEEDBACK LASERS: A COUPLED-MODE ANALYSIS OF TE GUIDED MODES" IEEE JOURNAL OF QUANTUM ELECTRONICS,US,IEEE INC. NEW YORK, vol. 31, no. 11, 1 November 1995 (1995-11-01), pages 1947-1954, XP000541540 ISSN: 0018-9197 the whole document	1-4, 16, 24-27
X	MEIER M ET AL: "LASER ACTION FROM TWO-DIMENSIONAL DISTRIBUTED FEEDBACK IN PHOTONIC CRYSTALS" APPLIED PHYSICS LETTERS,US,AMERICAN INSTITUTE OF PHYSICS. NEW YORK, vol. 74, no. 1, 4 January 1999 (1999-01-04), pages 7-9, XP000804554 ISSN: 0003-6951 the whole document	16-23
A	MILLER L M ET AL: "A DISTRIBUTED FEEDBACK RIDGE WAVEGUIDE QUANTUM WELL HETEROSTRUCTURE LASER" IEEE PHOTONICS TECHNOLOGY LETTERS,US,IEEE INC. NEW YORK, vol. 3, no. 1, 1991, pages 6-8, XP000202985 ISSN: 1041-1135 the whole document	1,5
X	YOSHIAKI WATANABE ET AL: "LATERALLY COUPLED STRAINED MQW RIDGE WAVEGUIDE DISTRIBUTED-FEEDBACK LASER DIODE FABRICATED BY WET-DRY HYBRID ETCHING PROCESS" IEEE PHOTONICS TECHNOLOGY LETTERS,US,IEEE INC. NEW YORK, vol. 10, no. 12, December 1998 (1998-12), pages 1688-1690, XP000802155 ISSN: 1041-1135 the whole document	1-3
A	US 5 684 817 A (HOUDRE ROMUALD ET AL) 4 November 1997 (1997-11-04) column 2, line 35 - line 60; figure 2C	1,16

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 00/03483

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5684817 A	04-11-1997	FR 2734097 A	15-11-1996
		DE 69608850 D	20-07-2000
		EP 0742620 A	13-11-1996
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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT



(PCT Article 36 and Rule 70)

Applicant's or agent's file reference HL76966/001/DCO	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/GB00/03483	International filing date (day/month/year) 08/09/2000	Priority date (day/month/year) 08/09/1999
International Patent Classification (IPC) or national classification and IPC H01S5/22		
Applicant UNIVERSITY OF BRISTOL et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 6 sheets, including this cover sheet.  
  
☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
These annexes consist of a total of two sheets.

## 3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand  28/03/2001	Date of completion of this report  29.11.2001
Name and mailing address of the international preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer  Gnugesser, H  Telephone No. +49 89 2399 2526  

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03483

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, pages:

1-5 as originally filed

### Claims, No.:

1-21 as received on 12/11/2001 with letter of 06/11/2001

### Drawings, sheets:

1/3-3/3 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03483

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Yes:	Claims	1-21
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-21
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-21
	No:	Claims	

2. Citations and explanations  
**see separate sheet**

## VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following documents:

D1: IEEE Photonics Letters, 3(1991)1, pages 6-8

D2: IEEE Photonics Letters, 10(1998)12, pages 1688-1690

D3: IEEE Journal of Quantum Electronics, 31(1995)11, pages 1947-1954

The documents D4 - D7 were not cited in the international search report. Copies of the documents are were appended to the written opinion.

D4: Patent Abstracts of JP10098235 A & US 5 982 804 A

D5: Patent Abstracts of Japan of JP 2 143 581 A

D6: J.Opt.Soc.Am.B, 10(1993)2, pages 399-403

D7: IEEE Journal of Selected Topics in Quantum Electronics, 5(1999)3,  
May/June 1999, pages 658 - 663

D8: US 5 684 817 A

2. Documents D1, D2 and D4 disclose distributed feedback ridge waveguide laser diodes with lateral **one dimensional grating structures** extending parallel to the ridges. Newly filed claim 1 which is based on orig. filed claims 8 and 9 is novel in view of these documents.

Documents D7, D3, D5 disclose two-dimensional gratings which extend over the whole laser surface parallel to the active layer. In case of the surface emitting laser device of D7 the surface with the two-dimensional grating is the light emitting surface. If the teaching of D3, D5 or D7 would be applied to conventional ridge waveguide laser devices with lateral distributed feedback gratings the two-dimensional grating would cover the whole upper surface of the corresponding laser diode. The ridge would be then grown on part of the grating structure. Therefore, the mere combination of a conventional ridge waveguide laser having lateral DFB gratings and the two-dimensional gratings of D3, D5 or D7 would not

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB00/03483

lead to the subject-matter of claim 1. It is also not obvious from the above documents that the provision of a two-dimensional grating structure only on the lateral sides of a ridge of a laser diode would still have lead to a desired distributed feedback effect.

Document D8 discloses a striped structure with lateral structures g1 and g2 of photonic bandgap material (holes formed in the photonic material). "The photonic material located on each side of the laser in the zones g1 and g2 determines the lateral guidance of the guide and forms a guidance stripe G in the guide". The document is silent that zones g1 and g2 also has a distributed feedback function. On the contrary, conventional diffraction gratings R are introduced (see e.g. fig. 2b).

Consequently, there is no reason for the person skilled in the art to develop the invention from the available p.a. without the exercise of inventive step.

Claims 2 - 21 are dependent claims which refer directly or indirectly back to claim 1 and are therefore also novel and involve an inventive step.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

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International application No. PCT/GB00/03483

**Re Item VII**

**Certain defects in the international application**

The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the closest prior art being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

In the present case, the following features are known in combination from the document D4 and belong in the preamble of such a claim:

"An optical device, comprising a laser diode having a ridge waveguide located above an active layer, and having a distributed reflector".

A document reflecting the closest prior art is not identified in the description (Rule 5.1(a)(ii) PCT).

**REPLACED BY  
ART 34 AMDT**

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**CLAIMS:**

1. An optical device, comprising a laser diode  
5 having a ridge waveguide located above an active layer,  
and having a distributed reflector located on either  
side of the ridge waveguide.

2. An optical device as claimed in claim 1,  
10 wherein the distributed reflector comprises a structure  
in material above the active layer on either side of  
the ridge waveguide.

3. An optical device as claimed in claim 1 or 2,  
wherein the distributed reflector comprises a two-  
15 dimensional structure in a plane parallel to the active  
layer and extends to a depth comparable to that of the  
active layer.

4. An optical device as claimed in claim 1, 2 or  
3, wherein the distributed reflector comprises a two-  
dimensional lattice when viewed from above the device.

20 5. An optical device as claimed in claim 1, 2 or  
3, wherein the distributed reflector comprises a two-  
dimensional lattice of holes etched into material above  
the active layer on either side of the ridge waveguide.

25 6. An optical device as claimed in claim 5,  
wherein the holes are arranged in a hexagonal array.

7. An optical device as claimed in claim 5,  
wherein the holes are arranged in a square array.

30 8. An optical device, comprising a laser diode  
having a ridge waveguide located above an active layer,  
and having a distributed reflector in the form of a  
lattice of individual elements, the elements being  
arranged in a two-dimensional array.

35 9. An optical device as claimed in claim 8,  
wherein the individual elements of the array are  
arranged on either side of the central ridge waveguide.

10. An optical device as claimed in claim 8 or

-7-

9, wherein the distributed reflector comprises a structure in material above the active layer on either side of the ridge waveguide.

11. An optical device as claimed in claim 8, 9  
5 or 10, wherein the distributed reflector comprises a two-dimensional structure in a plane parallel to the active layer and extends to a depth comparable to that of the active layer.

12. An optical device as claimed in claim 8, 9  
10 or 10, wherein the distributed reflector comprises a two-dimensional lattice of holes etched into material above the active layer on either side of the ridge waveguide.

13. An optical device as claimed in claim 12,  
15 wherein the holes are arranged in a hexagonal array.

14. An optical device as claimed in claim 12,  
wherein the holes are arranged in a square array.

15. An optical device as claimed in claim 8,  
wherein the individual elements of the array have a  
20 high refractive index contrast with the material of the device.

16. An edge emitting optical component, based on edge emitting laser diode structures, in which, single wavelength operation is achieved by design of a 2D-  
25 lattice distributed reflector so that efficient optical emission (by lasing and/or spontaneous emission) is achieved depending on the electrical bias or biases applied to the device.

17. An optoelectronic component, as defined in  
30 claim 16, wherein the modification of the structure may be achieved in manufacture through masking, e-beam lithography, X-ray or reactive ion etching (RIE) or other techniques or may be achieved through a post processing etching (such as focused ion beam etching  
35 (FIBE)) or oxidation step or other process.

18. An optoelectronic component, as defined in

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claim 16, wherein the structure may be an edge emitting Fabry-Perot lasing/amplifying/switching structure based on semiconductor/polymer technologies.

19. An optoelectronic component, as claimed in  
5 claim 16, wherein the lattice may be allowed to vary, both in terms of pattern, packing, overall shape and position.

20. An optoelectronic component, as claimed in  
10 claim 16, wherein the grating comprises holes that may be allowed to be vertical or at an angle and vary in size, spacing or shape.

21. An optoelectronic component, as claimed in  
15 claim 16, wherein the holes are defined as regions of different refractive index to that of the component structure.

22. An optoelectronic component, as claimed in  
claim 16, wherein the holes are defined as regions of different gain or loss to that of the component structure.

20 23. An optoelectronic component, as claimed in claim 16, wherein the holes are defined as regions of different refractive index and gain or loss to the component structure.

24. An optoelectronic component, as claimed in  
25 claim 16, wherein the grating may be introduced across the waveguide or waveguides on one or both sides.

25. An optoelectronic component, as claimed in  
30 claim 16, wherein the grating does not pierce the active region, partially pierce active region or possibly fully pierces the active region.

26. An optoelectronic component, as claimed in  
claim 16, wherein distributed gratings may be allowed within devices.

27. An optoelectronic component, as claimed in  
35 claim 16, wherein gratings may be allowed in pumped or un-pumped regions.

28. An optoelectronic component, as claimed in claim 26, wherein pumping may be of an electrical or optical nature.

5 29. An optoelectronic component, as claimed in claim 18, wherein any electrical contacts may be isolated.

30. An optoelectronic component, as claimed in claim 16, wherein the emission wavelength may be controlled/tuned.

10 31. An optoelectronic component, as claimed in claim 16, wherein the device may be operated at high speed.

32. An optoelectronic component, as claimed in claim 16, which operates mode-hop-free.

15 33. An optoelectronic component, as claimed in claim 16, which is integrated with separate amplifying, absorbing or passive sections.

20 34. An optoelectronic component, as claimed in claim 33, where the amplifying or absorbing regions may have gain/loss modulated.

35. An optoelectronic component, as claimed in claim 16, which may be pulsed by gain switching, Q-switching or mode-locking techniques.